IWMI WATER BRIEF 3

Water Scarcity and Poverty

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Poverty eradication through sustainable development can be regarded today as perhaps the central goal of the CGIAR, of most agricultural research and development institutions in the developing world, and of the national governments that support their research. *Irrigation* has played a central role in poverty reduction in the past. But the growing scarcity and competition for water and the overexploitation of groundwater resources suggest that past achievements in poverty alleviation in irrigated areas may be at risk. In addressing the poverty problem, we must consider the impact of reduced water availability for irrigation not only on crop production, but also on the wide range of other uses that are a part of the livelihood of rural agricultural communities. Meanwhile, poverty persists in many of the rain-fed and upland areas, the so-called *marginal* or traditionally *water-scarce areas.* In these areas, the inability to effectively mobilize water resources has prevented farmers from using modern yield-increasing inputs and raising incomes.

There are two regions of the world that stand out in terms of the scope and magnitude of rural poverty—South Asia and sub-Saharan Africa. They could not be more contrasting in terms of water resources and irrigation development and hence the challenge posed to IWMI scientists and others for poverty alleviation. With close to 40 percent of the crop grain area in South Asia irrigated (table 1), and with irrigated yields typically more than twice those of rain-fed, at least two thirds of cereal grain production and most of the marketed surplus comes from irrigated agriculture. This contrasts with approximately 5 percent for sub-Saharan Africa.

In this paper, we discuss the implications of growing water scarcity for poverty alleviation with particular reference to South Asia and sub-Saharan Africa. First, we briefly summarize the impact of irrigation development on poverty alleviation in South Asia for the recent past. Then in an environment of growing water scarcity, we examine the challenges that lie ahead for the development of water resources leading to sustained poverty alleviation. Emphasis is placed on the role that advances in irrigation technologies have played in the past in achieving *food security* and must play in the future in providing *water security* for the poor.

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Table 1. Estimates of values of food and agricultural crop production and percentages grown on irrigated land in developing countries 1988-89.

Crops	Value (US$ billion)		Percentage grown on irrigated land
	Total	Irrigated	
All crops	364.2	104.1	28.5
Food crops	310.8	96.1	30.9
All grains	148.3	69.1	46.5
Rice and wheat	117.1	67.1	57.1
Wheat	31.1	15.5	50.0
Rice	85.9	51.6	60.0

Source: Yudelman, 1994.

Irrigation and Poverty Alleviation—Past Achievements

Between the 1960s and the 1990s real food grain prices fell by approximately 50 percent. This decline was due principally but not entirely to the impact of the so-called *green revolution* in the developing countries. The subsidization of food grain production by the developed economies also contributed to the decline. Determining the precise share of the gains in cereal grain production attributable to new seeds, fertilizer, and irrigation is an almost impossible task. However, there is little doubt that without the advances in irrigation technologies and extraordinary investments in irrigation expansion by both the public and private sectors, the impact of the green revolution would have been greatly reduced.

The benefits of lower food grain prices to the poor are obvious. Sixty percent of the money spent on food by the people below the poverty line in Asia is apportioned for cereals (which provide as much as 70 percent of their total nutrients).

A second major impact of irrigation is in the employment generated both on and off the farm providing entitlement or purchasing power for the poor. For landless laborers, increased cropping intensity has the greatest impact on employment. Irrigation means more work in more days of the year. The employment impact is felt not only in the irrigated but also in the rain-fed areas. Sometimes, landless workers in the rain-fed villages migrate long distances to take advantage of employment opportunities in the irrigated areas. There is also a multiplier effect, with higher incomes in agriculture creating employment opportunities off the farm. Between the mid-1970s and 1990, the number of people below the poverty line in India fell from over 50 percent to approximately 35 percent (Datt 1998) while in Bangladesh it fell significantly (Palmer-Jones 1992). However, the absolute number of people below the poverty line increased slightly.

An important contributor to poverty alleviation was the growth in public-sector-funded canal irrigation and in largely private-sector-funded tube well irrigation (Shah 1993). Technological advances in storage dam construction and in tube wells and lift pumps enhanced this expansion and allowed a larger portion of the crops to be grown during the dry season. The dry-season environment of high solar energy and low pest infestation gives the highest crop yield response to fertilizer application. The tube well technologies in particular were instrumental in poverty reduction in eastern India and Bangladesh. The initial emphasis on publicly financed deep tube wells gave way to shallow tube wells (IIMI and BAU 1996). Manually operated hand pumps were replaced by treadle pumps and by engines. The cheaper and smaller Chinese engines allowed even the smaller farmers to invest in shallow tube well irrigation pumps rather than exerting energy by themselves and their families as a source of power for pumping (Palmer-Jones 1992). Many who could not afford this cheaper technology gained access through the development of water markets. To facilitate the spread of these technologies among the small farmers, credit schemes were developed by the Grameen Bank and other NGOs with particular emphasis being given to the role of women in loan taking and in managing the pumps (Van Koppen and Mahmud 1996).

There is a striking dissimilarity between the physical and socioeconomic environment in the irrigated lowlands of Asia and the rain-fed, water-scarce areas in sub-Saharan Africa and Asia. Strategies for water management that have been successful in reducing poverty in the former environment have proven to be largely inappropriate for the latter. There appears to be relatively few lessons from the South Asia experience with irrigation and poverty reduction that can be readily transferred to water-scarce rain-fed areas in sub-Saharan Africa and elsewhere. In fact, little progress has been made in raising agricultural productivity in the water-scarce rain-fed areas of Asia. Yet the road to increased productivity may lie not only with the introduction of new technologies but also with the exploitation of traditional technologies. (See for example, Agarwal and Narain 1997).

The Impact of Water Scarcity on the Poor

As we approach the next century, it is widely recognized that many countries are entering an era of severe water shortage. IWMI has undertaken a long-term program to improve the conceptual and empirical basis for the analysis of water in major river basins of the world (Seckler, Molden, and Barker 1998). The initial findings of this study project that in the first quarter of the next century 2.7 billion people or a third of the world's population will experience severe water scarcity. The bulk of this population will reside in the semiarid regions of Asia and in sub-Saharan Africa. Due to overexploitation of groundwater, food production will be adversely affected in two of Asia's major breadbaskets—the Punjab and the North China Plain.

What are the implications of these findings for the poor? Water is both a commodity and a natural resource and a perceived human entitlement. When Nobel Laureate, Amartya Sen (1981) wrote about poverty and famines in Bengal, he spoke of ‘entitlements’ in terms of purchasing power for food. The primary people affected by the famines were the landless rural poor. But in today’s environment of growing water scarcity the problem is more pervasive. An increasing number of the poor—rural and urban consumers, rural producers, and rural laborers—are coming to view access or entitlement to water as a more critical problem than access to food, primary health care, and education.

The typical urban household uses water for drinking and sanitation. But rural areas use water for a wide range of purposes. Even in irrigated areas water is used not only for the main field crops, but for domestic use, home gardens, trees and other permanent vegetation, and livestock (Bakker et al. 1999). Other productive uses include fishing, harvesting of aquatic plants and animals, and a variety of other enterprises such as brick making. In addition, irrigation systems can have a positive or negative effect on the environment. Thus, the withdrawal of water affects the rural household, rural economy, and environment in a number of ways. Water scarcity is exemplified by situations such as: the need to carry heavy pots of water several kilometers every day to meet households needs; the destitution of farmers who lose their lands or of the landless who lose their jobs because of lack of irrigation water; the loss of wetlands or estuaries because of upstream water depletion; increasing health problems due to water pollution and to a rise in incidents of water-borne diseases.

Experts in the field agree that the quantity of water is even more important than the quality in terms of its impact on human health. However, water scarcity leads to declining water quality and pollution, which has an especially adverse impact on the poor. Many (perhaps most) of the poorest people in developing countries are forced to drink water that is unfit for human consumption. They suffer from a range of skin and internal diseases and health problems.

As water is withdrawn from agriculture, more attention must be given in the management of irrigation systems to water needs for domestic and health purposes, and to other consequences such as the impact on the environment. Unfortunately, in the case of water for agriculture, allocation cannot be accomplished solely through pricing mechanisms. Along with farmers, other stakeholders including the poor should have a voice in how limited water supplies are to be allocated.

The Emerging Groundwater Problem

As noted above, the development and expansion of tube well irrigation contributed significantly to the increase in food production and reduction in poverty. However, in the arid and semiarid regions, the point has now been reached where the overexploitation of groundwater poses a major threat to environment, health, and food security—a threat to the welfare of the poor far more serious than that posed by the widely criticized construction of large dams.

The regions of China, India, the Middle East, and North Africa, projected in the IWMI study to fac*e severe water shortage*, are the areas where overexploitation of groundwater has been most pervasive. These areas have had a "free ride" over the past two to three decades. Tube well yields attributable to irrigation have typically been more than double the yields from canals and tanks (table 2). But the penalty for mismanagement of this common-pool resource is now coming due.

Table 2. Output impact of groundwater, canals and tanks, 1977-79.

Country	Tons of food grain per net irrigated hectare additional to rain-fed yield		
	Groundwater	Canals	Tanks
Punjab	4.4	2.1	-
Haryana	5.3	2.0	-
Andhra Pradesh	5.2	2.9	1.5
Tamil Nadu	6.0	2.1	1.8

Source: Dhawan, 1986.

The groundwater problem has two contradictory aspects. First, there is the rapid drawdown of freshwater aquifers mainly due to the worldwide explosion in the use of wells and pumps for irrigation, domestic, and industrial water supplies. Second, there is the opposite problem of rising water tables of saline and sodic water. Added to these two problems is the pollution of aquifers by toxic elements. Here again the poor often pay the price not only through loss of crop production or cropland, but also through a shortage of water for the range of uses noted above and through increased health problems. The recent discovery of extensive arsenic poisoning of the aquifers in Bangladesh provides a prime example of the adverse effects of groundwater mismanagement in one of the poorest countries of the world.

While the problems of groundwater are clear, the solutions are not. The pricing and regulation of pumping for this common-pool resource are not feasible. Even if they had the technical and management capacity, what country would be willing to pay the enormous cost of this policy in terms of reduced food production and domestic and industrial water supplies? The best way to recharge aquifers needs more careful analysis. Much of the seepage and surface runoff from canals recharges groundwater aquifers. Seen in this light, Chambers (1988) suggests that a major and perhaps the main beneficial effect of new canal irrigation is to distribute water through the command allowing it to seep and so provide water for lift irrigation. Dhawan (1993) points out that according to his calculations half of the crop output originating from tube-well irrigated lands in the Punjab is from groundwater that is of canal origin. In short, much of South Asian irrigation must be analyzed and should be managed from a basin perspective taking into account the complementary relationship between canal water and groundwater.

While there are technical solutions for reducing salinity, the financial costs of various options and the appropriate procedures for implementing management strategies at farm and system levels are not well understood. In sum, given the truly alarming threat of fresh groundwater depletion in the world, it is astonishing how little attention, whether in research or action, is given to this problem.

Marginal Areas

Poverty persists in the irrigated areas but especially in many of the rain-fed and upland or the so-called *marginal areas*. In fact, most of the areas of persistent poverty are areas that can be described as *water-scarce.* Much of sub-Saharan Africa, with its lack of developed water resources, fits into this category. To date, efforts to mobilize water resources have been largely unsuccessful. Carruthers and Clark (1981) cautioned that without careful pre-appraisal "the farmer's promised banquet may turn out to be simply an engineering picnic." And indeed many of the early irrigation projects in Africa all too frequently turned out to be "engineering picnics." Jones (1995) reports that 18 World Bank irrigation projects in sub-Saharan Africa cost US$31,238 per hectare, while 56 South Asian projects cost $1,746 per hectare. This explains why such a large portion of African projects received an "unsatisfactory" rating. Furthermore, many of these systems were in locations where the physical or the socioeconomic environment or both were ill-suited to irrigated agriculture.

In contrast to the expensive irrigation projects, agricultural scientists have shown that a number of cheaper water harvesting and supplemental irrigation technologies hold greater promise for increasing crop yields. But the adoption by farmers has been extremely limited, as the risk and costs seem to have outweighed the benefits (Oweis, Hachum, and Kijne 1999). However, many scientists strongly believe that the rain-fed areas and natural wetlands offer the greatest potential for production gains in the immediate future. But finding the combination of low-cost techniques and management practices to increase the productivity of rainwater and tap the potential of the natural wetlands continues to be the major constraint to the realization of this potential and a challenge to researchers at IWMI and elsewhere.

Developing a more intensive agricultural system may prove more costly than has been the case in Asia for two reasons. The ecological risks associated with intensification, particularly pests and diseases, might be more serious than those in Asia because intensive cropping has had no time to coevolve with the natural biotic environment. Likewise, as IWMI's research in Burkina Faso and Niger emphasizes, there has been little time for the development of the institutions such as credit, marketing, land and water rights that are essential to the sustainability of intensive agricultural systems (Abernathy et al. 1999 forthcoming). One cannot simply rely on the market to bring about the institutional changes needed. A strong role must be played by policy and the state in facilitating the institutional changes and adoption of technologies that will increase agricultural productivity (Lele and Stone 1989; Binswanger and Pingali 1988).

There are a number of recent advances in micro irrigation systems that show promise. For example, a drip irrigation system has recently been developed for poor farmers. Rather than install the hardware permanently, as is normally done, a portable system has been designed where the plastic pipes are carried from one row to another. As a result the same effect in terms of water efficiency and productivity can be achieved with only one-fifth as many pipes.

A management practice that may be suited to many water-scarce areas is called *precision irrigation*. This involves water delivery and application technology that allows almost all water delivered to be available to the crop. That is to say, there is a minimum loss due to seepage, percolation, and surface runoff. The combination of traditional and modern low-cost micro technologies coupled with the management of water resources for *precision irrigation* and the development of new varieties that are both drought-tolerant and competitive with weeds may offer new hope for reducing poverty in the marginal areas.

The Challenge for Poverty Alleviation

With the onset of the population explosion following World War II, poverty in the developing world has been associated with hunger and food security. The response has been to produce more food by increasing crop yields and expanding irrigation. Despite the advances in global food security, it has become increasingly clear that productivity alone could not win the *war against hunger*. Poverty alleviation has become associated less with food production *per se* and more with *livelihood* (Chambers 1988), with employment, and with Amartya Sen's *entitlements* to food. Identifying a *poverty line* based on daily per capita income and measuring the reduction in the number of people below the *poverty line* have constituted the popular "yardstick" by which progress in poverty alleviation is measured. The growing scarcity of water relative to food in many parts of the world suggests that this may no longer be an appropriate yardstick. Access or entitlement to water is not simply a matter of having more money or purchasing power. *Water security* is an increasingly important element of any poverty eradication program.

Much is known already about policy and program design for *food security* and even about policy frameworks required for *environmental security*. By contrast, little is known about the appropriate mixes of policies, institutions, and technologies that could help achieve *water security* for both men and women in water-stressed environments (Webb and Iskandarani 1998). Furthermore, because of the multiple use of water—even water designated for irrigation—there are a large number of stakeholders among government agencies and the private sector who have a keen interest in water allocations. A basin approach to water management and allocation will be required to utilize water more efficiently (Seckler 1999) and to take into account off-site effects of more narrowly focused projects such as reforestation, which can have a negative impact on marginal upland farmers (Finlayson 1998; Starkloff 1998). As water becomes scarcer, the conflict over water allocations, rights and entitlements at farm, system and basin levels is bound to increase. New water basin institutional arrangements will be required to assure both efficiency and equity in use of basin water resources and to protect the interests of the poor.

Irrigation consumes about 70 percent of the world's available water. Subsidies for infrastructure have been reduced, the most accessible and cheapest water resources have been developed, and in an increasing number of basins all of the water has been committed. Demand for water for higher-valued uses—domestic, industry, and hydropower—is rising. The agriculture sector must produce more food with less water. Achieving this goal is thought by many to lie largely in improving the efficiency of canal irrigation systems. As suggested above, however, we believe that there must be more attention through research and action programs on the management of groundwater and surface water in a basin context in irrigated areas and on assessing the potential of alternative low-cost micro irrigation technologies in raising crop production in water-scarce rain-fed areas.

There is an urgent need for new strategies to improve the productivity of water in both irrigated and rain-fed agriculture, and ensure access to water and technologies by the poor. As new policies, institutions, and technologies are devised and tested to achieve this goal, a major task of IWMI will be to design strategies to enhance *water security* for poor men and women, a critical step in *poverty eradication.*

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